Using Model-Theoretic Invariants for Semantic Integration

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 2004		**00-00-2004 to 00-00-2004**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Using Model-Theoretic Invariants for Semantic Integration	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **National Institute of Standards and Technology (NIST),Manufacturing Engineering Laboratory,100 Bureau Dr,Gaithersburg,MD,20899**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

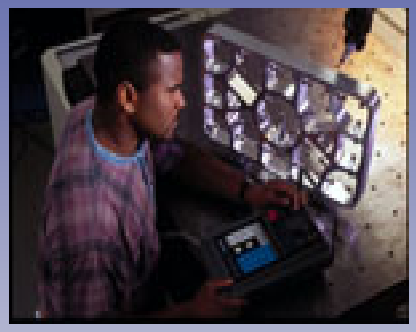
13. SUPPLEMENTARY NOTES
Proceedings of the 2004 Performance Metrics for Intelligent Systems Workshop (PerMIS ?04), Gaithersburg, MD on August 24-26 2004

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**14**	

Interoperability

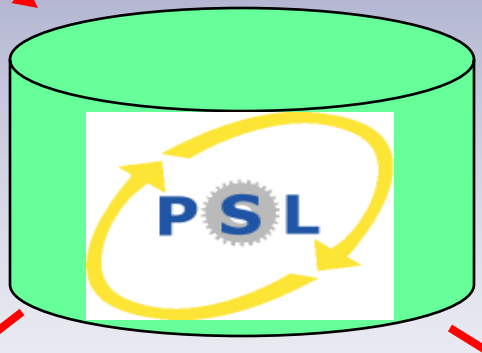


Process Modeler

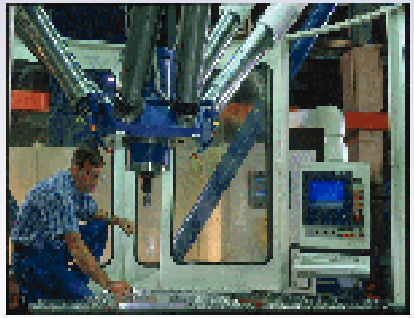
(ProCAP / KBSI)

Process Planner

(MetCAPP/Agiltech)



Simulator (Quest / Dessault)



Scheduler

(ILOG Scheduler)

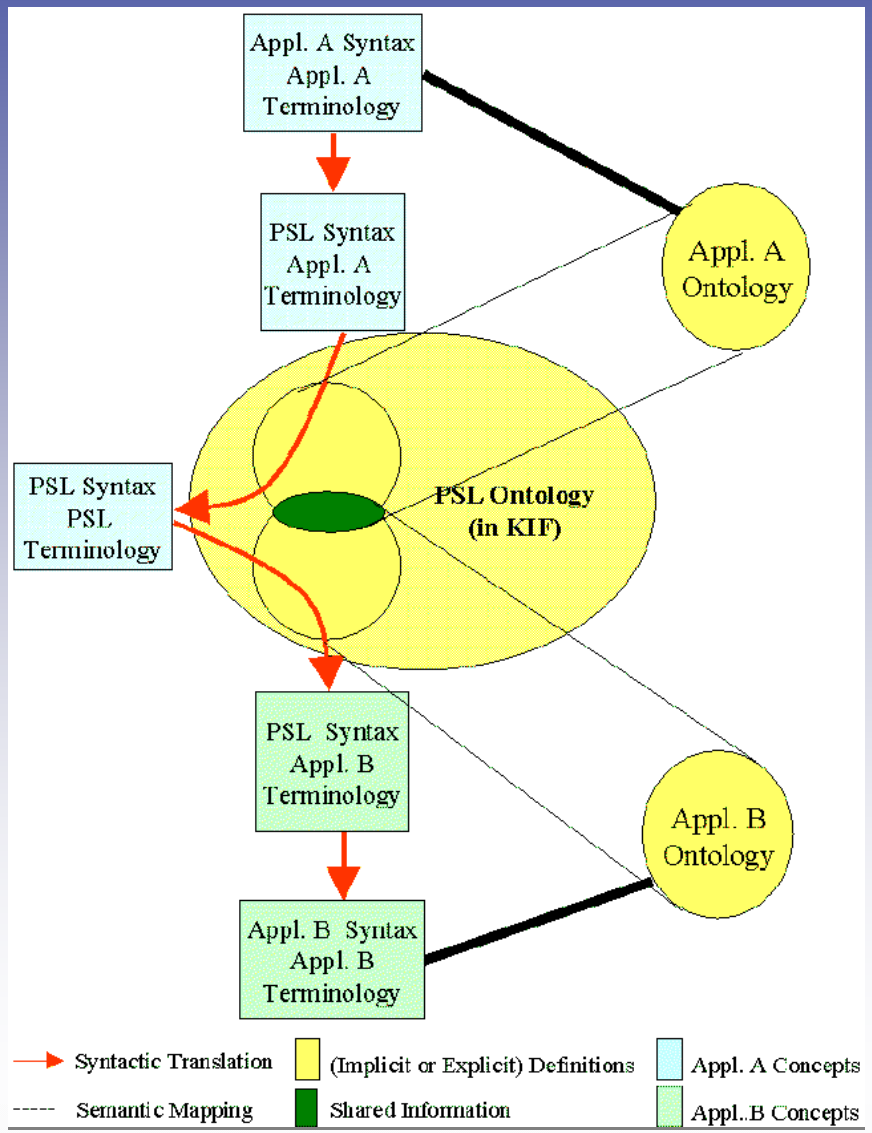
Semantic Translation

Translation definitions specify the mappings between PSL and application ontologies.

Example: The ***AtomicProcess*** in OWL-S maps to the ***activity*** concept in PSL only if the activity is atomic and its preconditions and effects depend only on the state prior to the occurrences of the activity.

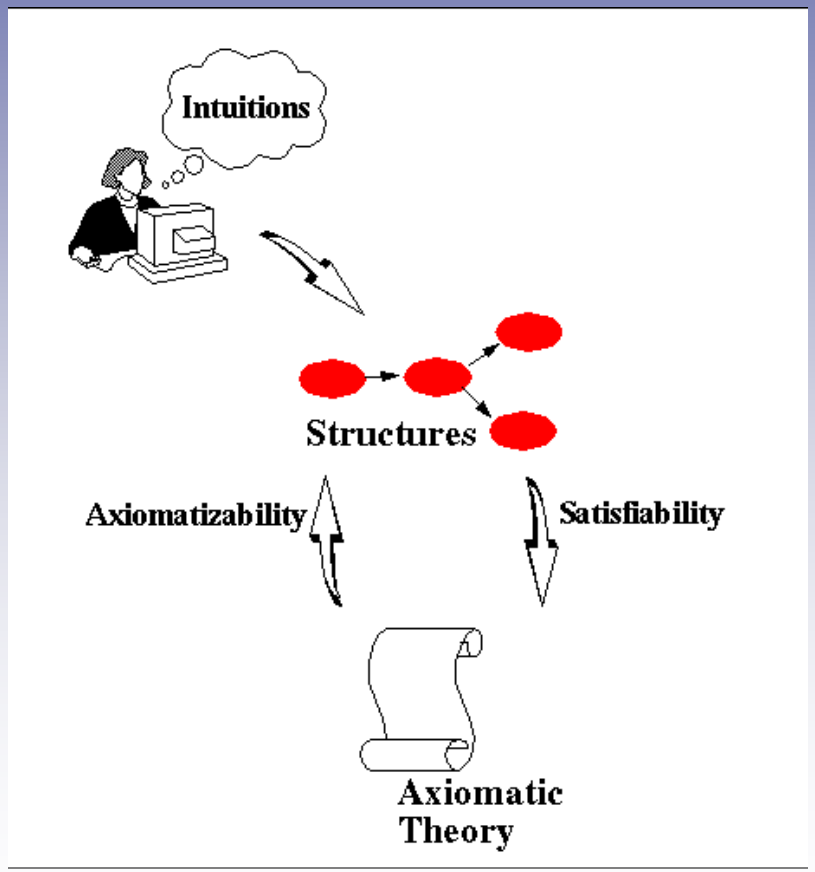
```
(forall (?a)
        (iff     (AtomicProcess ?a)
                 (and    (atomic ?a)
                         (markov_precond ?a)
                         (markov_effects ?a))))
```

Semantic Interchange Protocols



- What are sufficient conditions for an ontology to support this approach to semantic integration?

Verified Ontologies

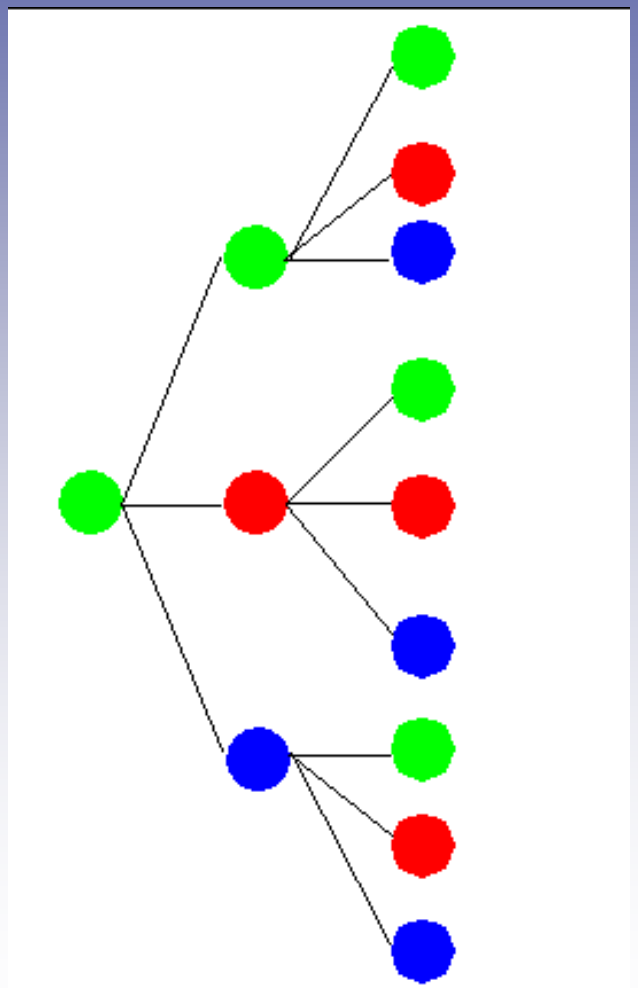


- The meaning of terms in the ontology is characterized by models for first-order logic.
- The ontology provides a first-order axiomatization of the class of models

Definitional Extensions

- Preserving semantics is equivalent to preserving models of the axioms.
  - *preserving models = isomorphism*
- We classify models by using *invariants* (properties of models that are preserved by isomorphism).
  - automorphism groups, endomorphism semigroups
- Classes of activities and objects are specified using these invariants.

Models in PSL



- Occurrence trees
- Fluents (state)
- Activity trees

Twenty Questions

How can we generate translation definitions?

- Each invariant from the classification of models corresponds to a different question.
- Any particular activity or object will have a unique value for the invariant.
- Each possible answer to a question corresponds to a different value for the invariant.

Limitations

- Not all theories have complete sets of invariants
- Invariants may not be first-order definable
- How do we determine the correctness of the translation definitions?

Interoperability Hypothesis

- We are considering interoperability among complete first-order inference engines that exchange first-order sentences.

- *Why first-order logic?*
  - Soundness and completeness guarantees that a sentence is provable from a theory if and only if it is satisfied in all models of the theory.

Ontological Stance

$\Sigma \cup \text{Ontology} \models \Phi$

Summary

- The meaning of terms in the ontology is characterized by models for first-order logic.
- The PSL Ontology has a first-order axiomatization of the class of models.
- Identify invariants of the models
- By axiomatizing these invariants, translation definitions can be shown to preserve semantics between software applications.

Further Questions?

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